FIG. 20 is a perspective view illustrating assembly of a guard member with the shield extension member;

FIG. 20A is a perspective view of the distal end portion of the trocar assembly of FIG. 1;

FIG. 20B is a perspective view of an existing trocar assembly design;

FIG. 21 is a longitudinal cross-sectional view taken through the distal end of the components illustrated in FIG. 20;

FIG. 22 is a view similar to FIG. 21, showing the guard element attached to the distal end of the shield extension member;

FIG. 23 is a longitudinal cross-sectional view taken through the obturator assembly;

FIG. 24 is an enlarged view of the indicated area of detail of FIG. 23;FIG. 25 is a longitudinal cross-sectional view taken through the trocar assembly of the present disclosure;

FIG. 26 is an enlarged view of the proximal end components of FIG. 25;

FIG. 27 is view similar to FIG. 25, which shows insertion of a trocar assembly through the skin of a patient; and

FIG. 28 is an enlarged view of the proximal end components of FIG. 27.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring initially to Figs. 1 and 2, one embodiment of a modular trocar system in accordance with the present disclosure is designated by reference numeral 100 throughout the several views. Modular trocar system 100 is particularly adapted for use in minimally invasive surgical procedures such as endoscopic or laparoscopic procedures.

Generally, modular trocar system 100 includes two principal subassemblies, namely an obturator assembly 110 and a cannula assembly 112. Cannula assembly 112 includes a seal assembly 114 and a cannula 116, as described in detail further herein.

Except where noted otherwise, the materials utilized in the components of the presently disclosed modular trocar system generally include materials such as either ABS or polycarbonate for housing sections and related components and stainless steel for components that are required to cut tissue. A preferred ABS material is CYCOLAC which is available from General Electric. A preferred polycarbonate material is also available from General Electric under the trademark LEXAN. An alternative polycarbonate material which may be utilized is CALIBRE polycarbonate available from Dow Chemical Company. The polycarbonate materials may be partially glass filled for added strength.

Referring now to FIGs. 3-9, and initially to FIGs. 3-6, obturator assembly 110 includes an obturator housing 118 formed from housing base 119 and cylindrical housing cover 120. Once the appropriate components are positioned therewithin (as described below), housing base 119 may be attached to cylindrical housing cover 120 by engaging mating surfaces, for example by resilient latches 122 formed on cover 120 interlocking with correspondingly shaped engaging surfaces 123 (FIG. 24) formed in the housing base 119. To uniformly connect base 119 and cover 120, preferably at least three corresponding latches 122 and engaging surfaces 123 are provided and are spaced evenly around the circumference of cover 120 and housing base 119, respectively. Base 119 and cover 120 are preferably molded from an ABS material and are preferably configured and dimensioned to functionally cooperate with various sizes of cannulas, e.g., 5-15mm. Thus, obturator housing 118 is adapted to be a modular component for use with a wide range of trocar assemblies.

When fully assembled, obturator assembly 110 includes a safety shield assembly that is movable with respect to a penetrating tip such as, for example, knife blade 125. The safety shield assembly includes a shaft formed from an elongated hollow shield member 126 and a shield extension 127. A distal guard member 128 is attached to

the distal end of shield extension 127. Preferably, all of the safety shield assembly components are molded from a polycarbonate material. Guard member 128 is preferably formed as a "dolphin nose" to help minimize the force necessary to penetrate the body. As shown in FIG. 5, the distal section of elongated shield member 126 is provided with a pair of opposing receiving holes 148 (only one is visible) to facilitate interaction with shield extension 128, as will be described below. Elongated shield member 126 also includes a proximal end portion such as collar 130 having a shield position indicator, such as indicator flag 132, extending transversely relative to elongated shield member 126. Preferably flag 132 is colored to contrast sharply with the surrounding housing components. For example, indicator flag 132 may be red if the surrounding housing components are white or light colored. Proximal end portion of collar 130 includes a bearing surface such as ledge 134 and a pair of posts 135 formed below ledge 134 and extending transversely outwardly.

Elongated shield member 126 is disposed within a longitudinal throughbore 136, FIG. 3, formed through cylindrical extended portion 138 of housing base 119 with a distal end surface of collar 130 abutting housing base 119 on a proximal face thereof. Cylindrical extended portion 138 may be molded as part of housing base 119 or molded separately and mounted to housing base 119, e.g., by sonic welding. Cylindrical extended portion 138 provides transverse support to the shield and obturator components that pass therethrough and preferably includes an inward taper 139 at its distal end to facilitate passage through valve/seal assemblies. Abutment between the distal and surface of collar 130 and housing base 119 limits distal movement of shield member 126 relative thereto. Ledge 134 interacts with a slot 149 formed in a latch member 150 molded as part of base 119 to assist in the angular orientation of shield member 126 relative to housing 118.

The safety shield assembly further includes a coil spring 140 the distal end of which is seated in shield member 126 in an opening formed at the proximal end of collar 130. Referring temporarily to FIG. 14, housing cover 120 preferably includes a distally directed, hollow cylindrical post 144 molded to the proximal face thereof.